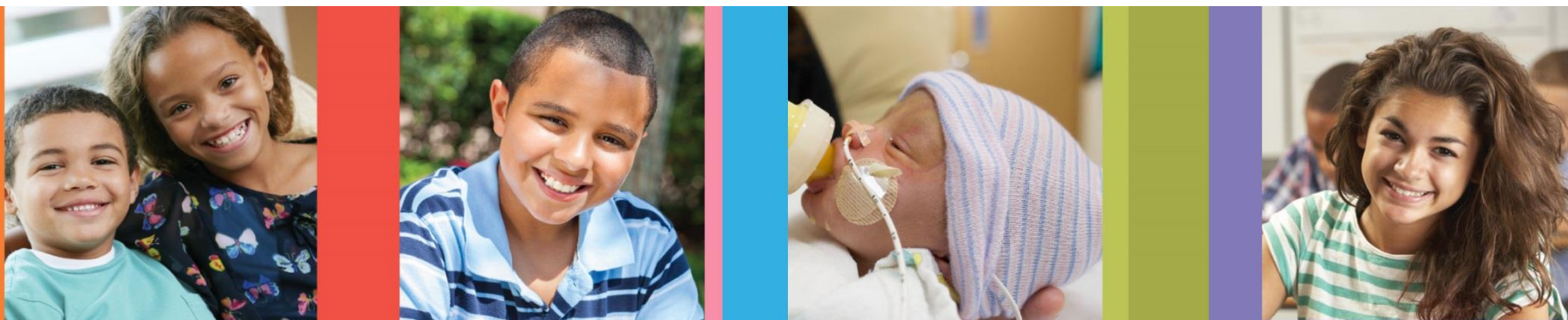




UCSF Benioff Children's Hospital
Oakland



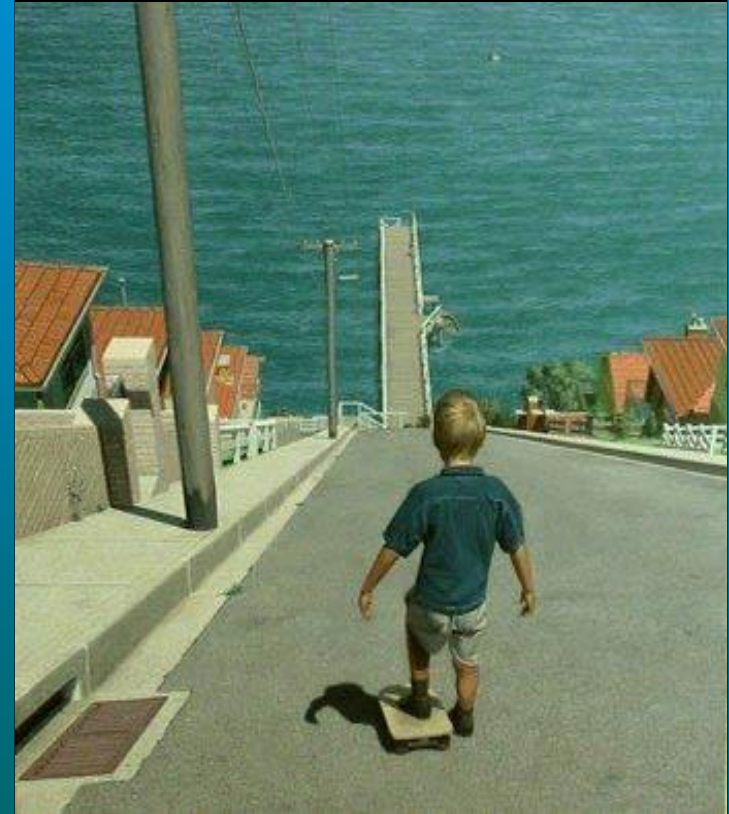
Nuances of Pediatric Trauma: Recognizing Trouble

Christopher Newton, MD
Trauma Medical Director
Benioff Children's Hospital Oakland

Outline

- What is a pediatric trauma center?
- Systems:
 - How should they be used?
- Pediatric Trauma Outreach Program
 - Recognizing Pediatric Extremis

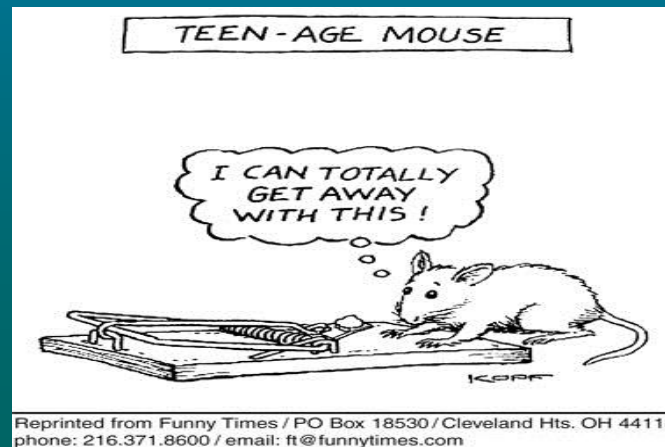
Recognizing Trouble



FAIL!

Leading Causes of Pediatric Deaths in the United States

	First	Second	Third	Fourth
1-4	Injury	Congenital	Cancer	Homicide
5-9	Injury	Cancer	Congenital	Homicide
10-14	Injury	Cancer	Homicide	Suicide
15-19	Injury	Homicide	Suicide	Cancer



Pediatric Trauma in the US

- 22 million pediatric injuries per year
- 18,000 mortalities per year
- Injury is the leading cause of childhood hospitalization
- 25% of all injured patients in the US are pediatric

Estimated 2-3% of pediatric injuries are treated at specialty hospitals



W. Eugene Smith—Time & Life Pictures/Getty Images

The Controversy:

- Regionalization of pediatric trauma care

vs.

- Broad primary pediatric resources



The Good, Bad and Ugly

Regionalized care

- **Good:**

- High level tertiary care with complete support services
- Maintenance of experience with volume

- **Bad and Ugly**

- Distance and time
- NO experience for non-peds centers
- Overwhelming volume on limited resources



The Good, Bad and Ugly

Broad Based Care System

- **Good:**
 - Local care
 - Experience for all with system redundancy
- **Bad and Ugly**
 - Not enough peds specialty resources
 - Tremendous expense
 - Diffusion of experience: no one gets good care!

Is there a compromise?

Hybrid Tiered Pediatric EMS system:

- Take the best of both and minimize the bad!!!
- Local general hospitals must:
 - Know their resources and limitations
 - Know when to “pull the transfer trigger”
 - Have plans and agreements in place

“Rapid Re-Triage”

- Recent concept for adult and peds patients
- Pre-arranged agreements for rapid transfer and acceptance
 - Patients must meet specified criteria
 - 911 resources *may* be used
 - Modifications based on regional needs and resources



Re-Triage Algorithm

CONTRA COSTA PEDIATRIC EMERGENCY TRAUMA RE-TRIAGE PROCEDURE

Step 1	Determine if patient meets Emergency Trauma Re-Triage Criteria	See Criteria Below – Pediatric Patients are below age 15
Step 2	Contact Trauma Center	Childrens Hospital and Research Center – Oakland
Step 3	Determine appropriate level of transport and arrange transport (can be done simultaneous to Trauma Center contact)	If within Paramedic Scope of Practice and timely transfer needed – Contact 911 to request Emergency Interfacility Transfer . Transport should generally arrive within 10 minutes. If exceeds paramedic scope of practice, contact appropriate transport agencies (CCT-RN or Air Ambulance) or arrange for nursing staff to accompany paramedic or EMT ambulance.
Step 4	Prepare patient, diagnostic imaging disk(s), and paperwork for immediate transport.	Fax additional paperwork that is not ready at time of transport departure. Do not delay transport. EMS transport to make radio contact with receiving hospital to provide ETA.

EMERGENCY TRAUMA RE-TRIAGE CRITERIA - PEDIATRIC

Blood pressure / perfusion:

- Hypotension or tachycardia (based on age-appropriate chart below) or clinical signs of poor perfusion (see below)
- Need for more than two crystalloid boluses (20 ml/kg each) or need for immediate blood replacement (10 ml/kg)

GCS / Neurologic

- GCS Less than 12 (pediatric scale – see verbal scale below)
- GCS Deteriorating by 2 or more during observation
- Blown pupil
- Obvious open skull fracture
- Cervical spine injury with neurologic deficit

Anatomic criteria

- Penetrating injuries to head, neck, chest, or abdomen

Respiratory Criteria

- Respiratory failure or intubation required

Provider judgment

- Patients, who in the judgment of the evaluating emergency physician, are anticipated to have a high likelihood for emergent life- or limb-saving surgery or other intervention within 2 hours.

Pediatric Trauma Center Definitions

Designation

Verification

“adult center treating children”

EMSC



“Designation”

- Title 22
 - Specific Peds level 1&2 criteria
 - Volume criteria not specified
- LEMSA: Designating Authority
- Trauma System Plan:
 - Triage and destination
 - Critical Care capabilities
 - Pediatric hospitals “if applicable”



State of California

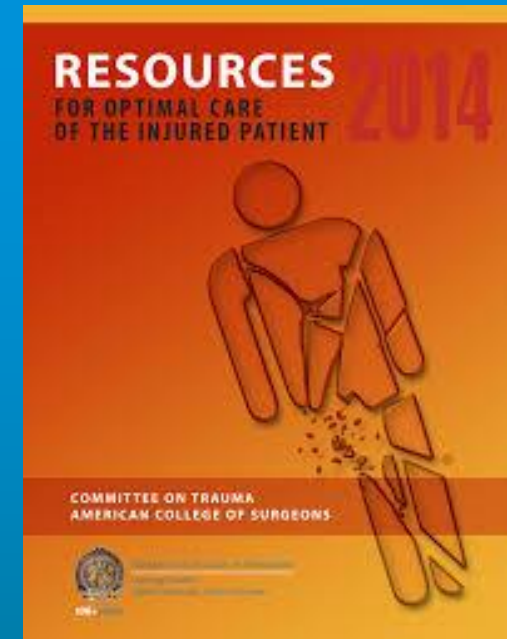
**Title 22, Division 9: Prehospital Emergency
Medical Services Regulations in Effect as of
January 1, 2014**

**Emergency Medical Services Authority
Health and Human Services Agency**



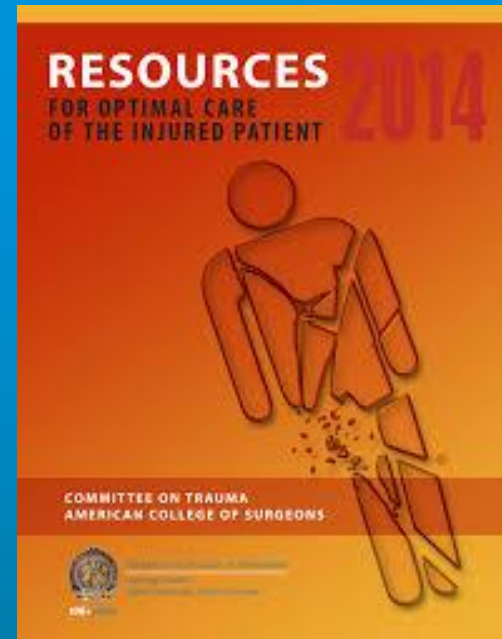
ACS Verification

- Pediatric Criteria
 - Volume standards
 - Level 1 >200
 - Level 2 >100
 - Dedicated personnel
 - TMD, Program Manager, Registrar, PIPS program
 - Specialty programs
 - Rehab, Child life, Child protection, injury prevention



ACS Verification

- Pediatric Criteria
 - Research, education, outreach
 - Primarily for Level 1
 - Peds Specific CME and education
 - Board Certified Specialty credentials
 - Surgery, Ortho, Neurosurgery
 - Critical care, Emergency Department
 - Radiology, Anesthesia, rehab
 - facilities and equipment
 - Separate ER and ICU



EMSC: Pediatric Readiness Project

- Title 22 and ACS: No level 3
- EMSC: for everyone
 - Peds readiness checklists:
 - MCI
 - Medications
 - Equipment
 - Surge capacity
 - Decontamination
 - Safety and security



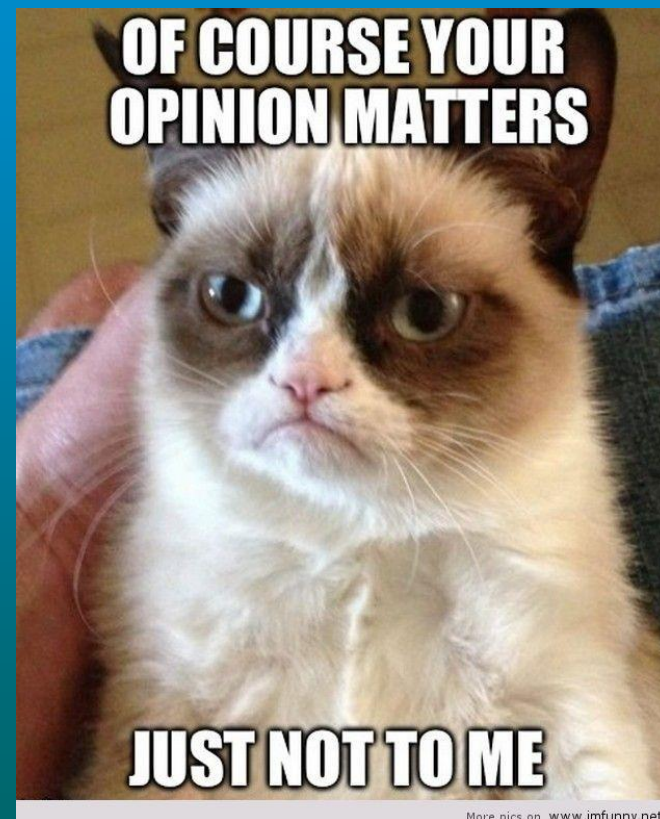
Pediatric Trauma Benchmarks and Quality Measures

- Mortality, complications, process improvement
- TQUP Benchmarks
- Radiology usage
- Splenectomy rates

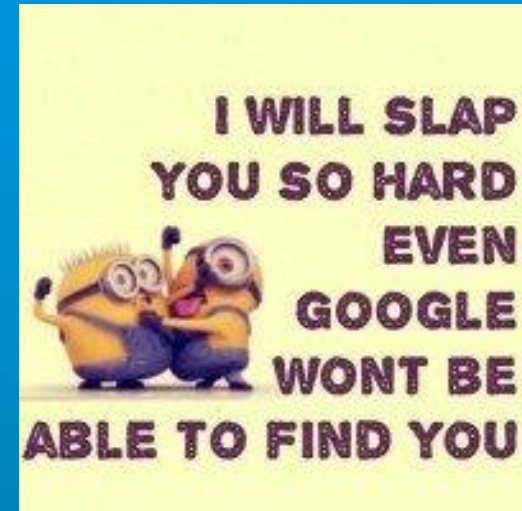


What should we be doing?

- Level 1 responsibility:
 - Mentoring and Development
 - PIPS support
 - EMSC minimum standards
 - Transfer agreements
 - Education programs
 - Research programs



Peds “Partnerships”



- Not ALL peds trauma needs to go to tertiary level centers.
- But – receiving hospitals should have some *comfort and confidence* in treating minor trauma
- AND – receiving hospitals need to *know who, when and how to transfer!*

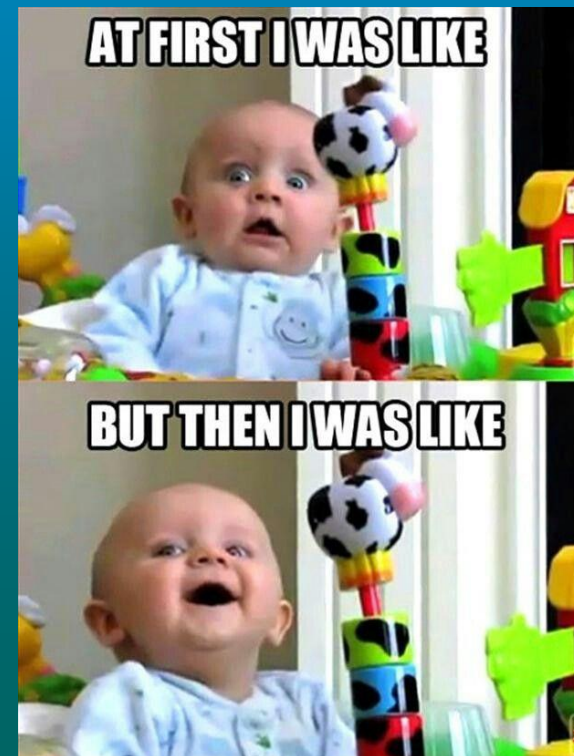
Cincinnati Experience

“Pediatric Trauma Transformation Collaborative”

- “buddy hospital” system
- Training, mentoring, and CME conferences
- 24/7 Pediatric trauma surgeon phone support
- Supported PIPS program, combined MM meetings
- *Alternative pathway to ACS verification for distant hospitals that otherwise could not do it*

CHO Outreach Courses

- Things that make Peds a little different (or a little scarier):
 - Recognizing Extremis
 - Pediatric TBI
 - Non-Accidental Trauma
 - Pediatric Sports Medicine and Rehab



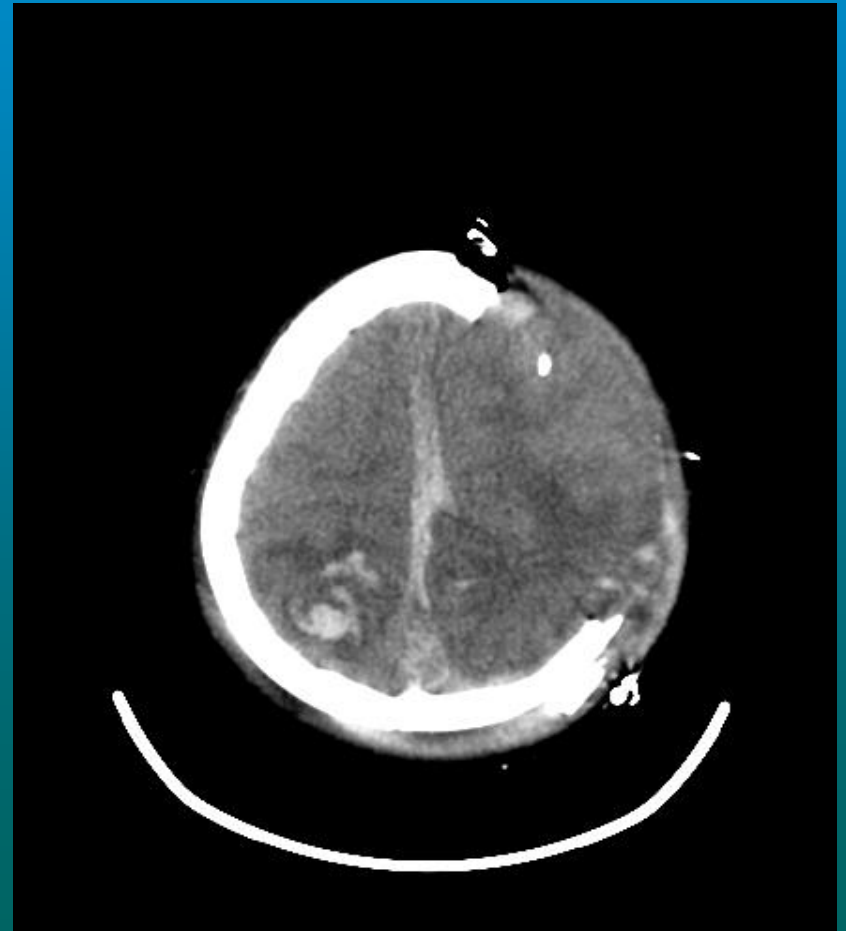
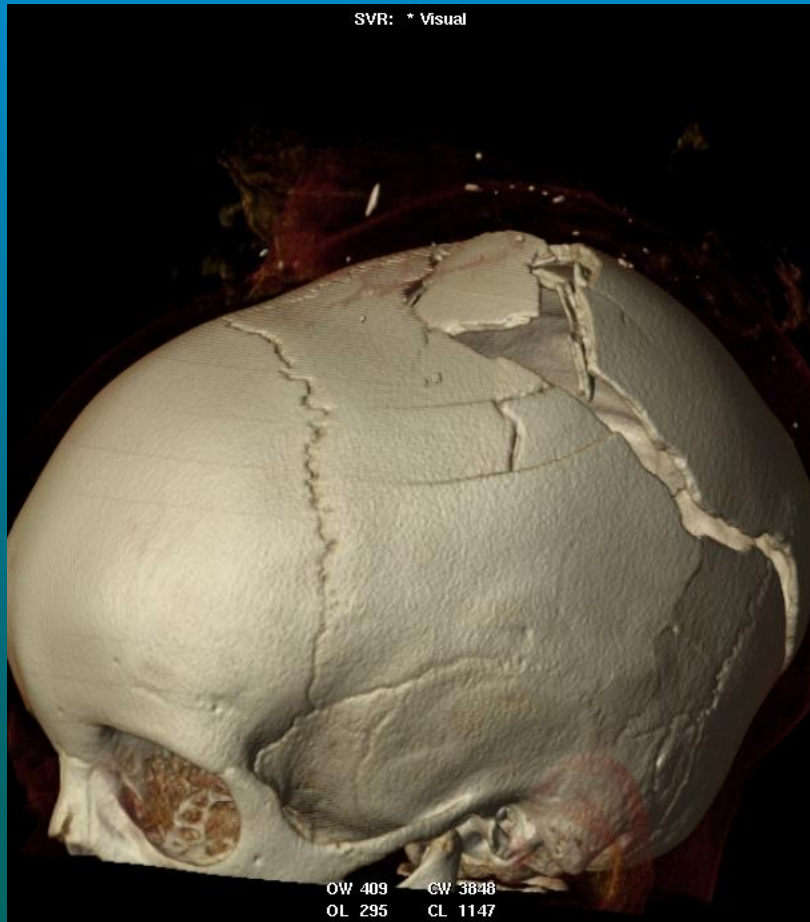
BCHO: Recognizing Pediatric Extremis Course (RPE)

Case Based Learning

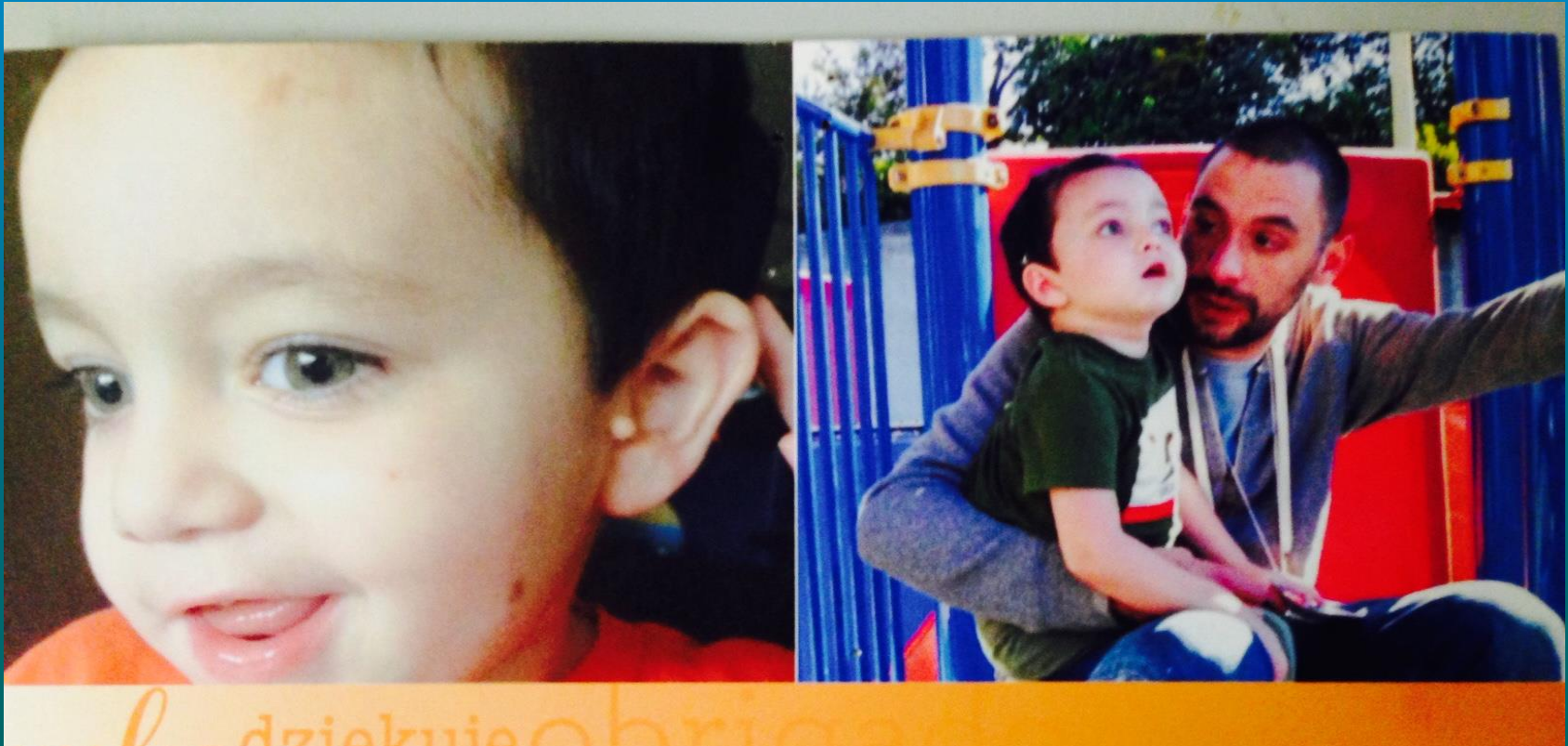
- Airway Compromise
- Respiratory Distress
- Hypovolemic Instability
- Neurologic Deficits
- Hypothermia
- Victims of Maltreatment (NAT)



CASE #1: Three year old boy survives roll over car accident, mom dies, “brain matter splattered on front of chest..”



Four months later: “He’s walking
now; tried to catch a butterfly
yesterday...”

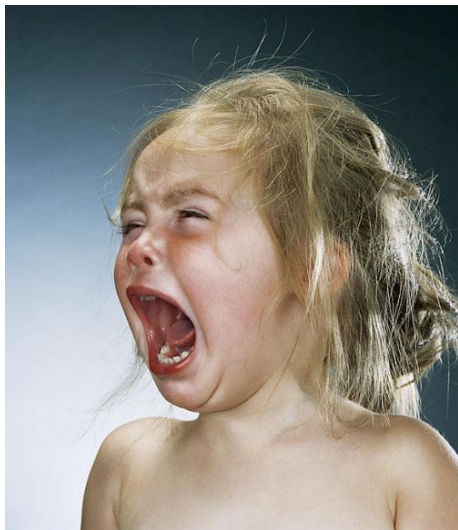


Lesson:

- Sometimes kids are different!



RPE: What is Extremis???



I know it when I see it!!

Yeah, Maybe ...

Maybe NOT!!!



Across the Room Observation

First impressions

Rapid assessment of overall stability

PAT: Pediatric Assessment Triangle

Immediate identification of
Life Threatening Conditions

Intervention based on **Risk Potential**

Trauma = Hemorrhage/Neurologic Injury

Level of Consciousness

AVPU: Alert, Verbal stimuli, Painful stimulation, Unresponsive



Priorities

**Treat the greatest
life threatening
emergency first!**

**Priorities may
change as the
patient's condition
changes...**



Pediatric Trauma Basics

- **A - Airway**
- **B - Breathing**
- **C - Circulation**
- **D - Disability**
- **E – Environment**
- *F - Family*

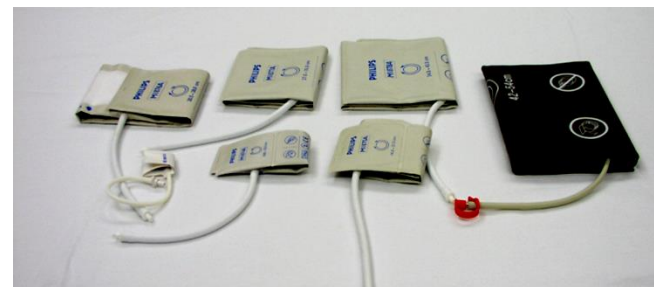
C-A-B (Not A-B-C)



Size Matters

Weight is essential- Broselow

Choose the appropriate sized monitoring equipment to accurately assess vital signs



Too large



Too small



Just right

Pediatric Vital Signs

Reference ranges are guidelines for normal. Always follow local protocols. Each patient's individual clinical situation should always be assessed.

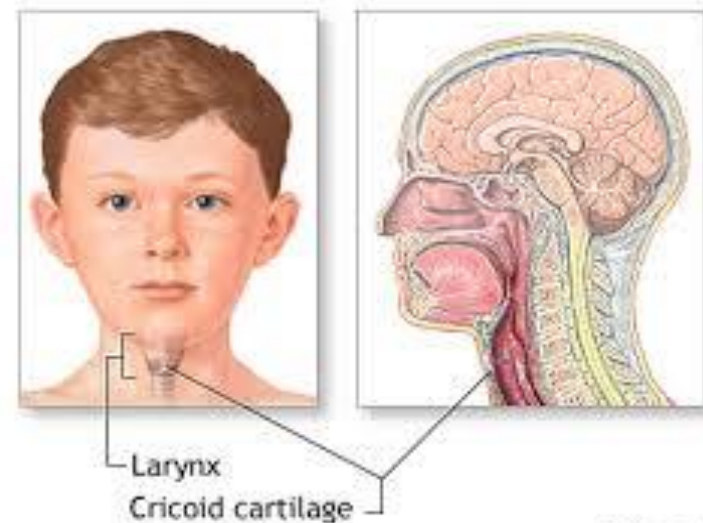
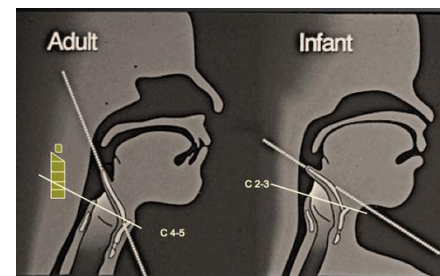
AGE	WEIGHT	RESP RATE	HEART RATE	SYSTOLIC BP	LENGTH	BROSELOW COLOR
Newborn	3-5 Kg	30-60	80-190	65-104	50 cm	Grey -Pink
6 mos	8 kg	30-60	80-160	70-110	62 cm	Red
1 Year	10 Kg	20-45	80-160	70-112	74 cm	Purple
2 Years	13 Kg	20-45	80-140	70-112	82 cm	Yellow
3 Years	15 Kg	16-40	80-140	75-116	95 cm	White
5 Years	20 Kg	16-40	75-130	75-116	108 cm	Blue
8 Years	25 Kg	16-35	70-120	80-112	127 cm	Orange
10 Years	30 Kg	16-30	65-115	85-126	138 cm	Green
15 Years	55 Kg	12-24	60-110	90-136	155 cm	No Broselow

?

Pediatric Airway and Breathing

Anatomy and Physiology:

- Smaller airway diameter—easily occluded
- Shortened trachea
- Large tongue
- Larynx more anterior (difficult to visualize)
- Passive flexion due to large head
- Floppy epiglottis: May restrict use of curved ET blade
- C-spine precautions (lax ligaments, subluxation, SCIWORA)



Pediatric Airway and Breathing

Assessment: What does normal look like?

- Assess for breath sounds in both upper and lower airways.
- Appearance of a Child in Respiratory Distress includes:
 - Skin Color
 - Retractions
 - Nasal Flaring
 - Position of Comfort
(or lack of!)
 - **Lethargy or irritability**



Pediatric Airway and Breathing

Observation:

1. Extremis?
2. Upper or Lower?



Lower Respiratory conditions

- Wheezing/Asthma/RAD
- Pneumonia
- Foreign body aspirate
- Chemical/Smoke inhalation
- Pneumothorax/hemothorax
- Pulmonary contusion

Upper Airway Conditions

- Foreign Body Aspiration
- Obstruction: blood, vomitus, teeth, secretions
- Croup vs. Epiglottitis
- Tracheal injury (crepitus, voice change, unable to swallow)

Pediatric Airway and Breathing

Interventions:

- Allow the child to assume their *position of comfort*
- *Nasal/Oral high flow as needed*
- NPO
- Administer oxygen via non-rebreather mask (*good luck!*)
- Assist ventilation- BLS airway and Bag Valve Mask
- Prepare for RSI*
- *Weight Based Medication***
- Facilitate family presence



Pediatric Circulation

Assessment:

- Tachycardia
- Weak peripheral pulses
- Skin color: pale, dusky, mottled
- **Capillary Refill** > 3 seconds
- Hypotension (late sign)
- Temperature- cold
- Decreased LOC



Pediatric Circulation

Interventions:

- Two large bore IVs (22G or larger)
- Normal Saline Lock
- 20ml/Kg Crystalloid Solution (Normal Saline)
- Consider Colloid fluid resuscitation (Blood) 10ml/Kg
- Damage control resuscitation: control active bleeding*
- Warming Measures

**Estimated pediatric circulating blood volumes = 70 ml/kg



Pediatric Circulation

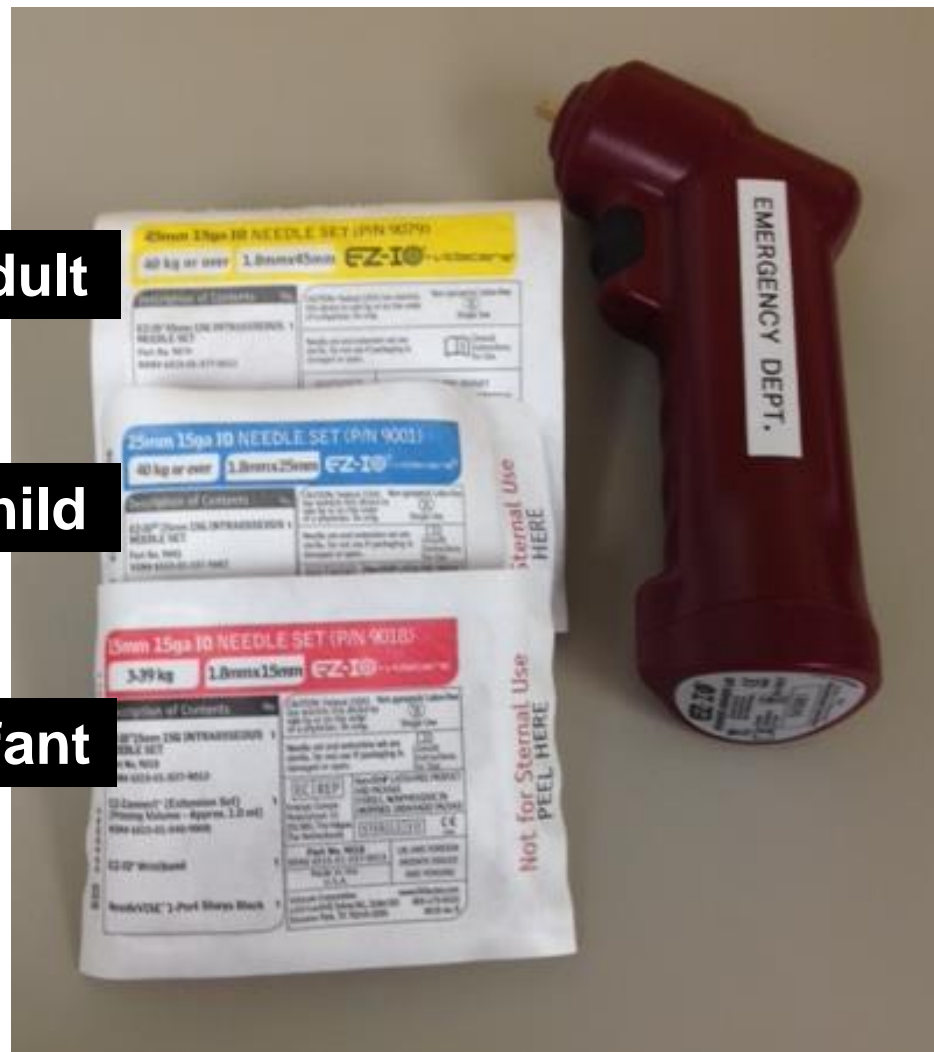
If the patient is in extremis, go to IO after two unsuccessful attempts at peripheral IV access.

Think twice before placing central access!

Adult

Child

Infant



Head Injury

Pediatric TBI

- Mass lesions: ICH, EDH, SDH
- Skull fracture: linear, depressed, open, BSF
- Penetrating injury
- Diffuse injury
- Non-accidental injury/trauma (NAT)
- Concussions

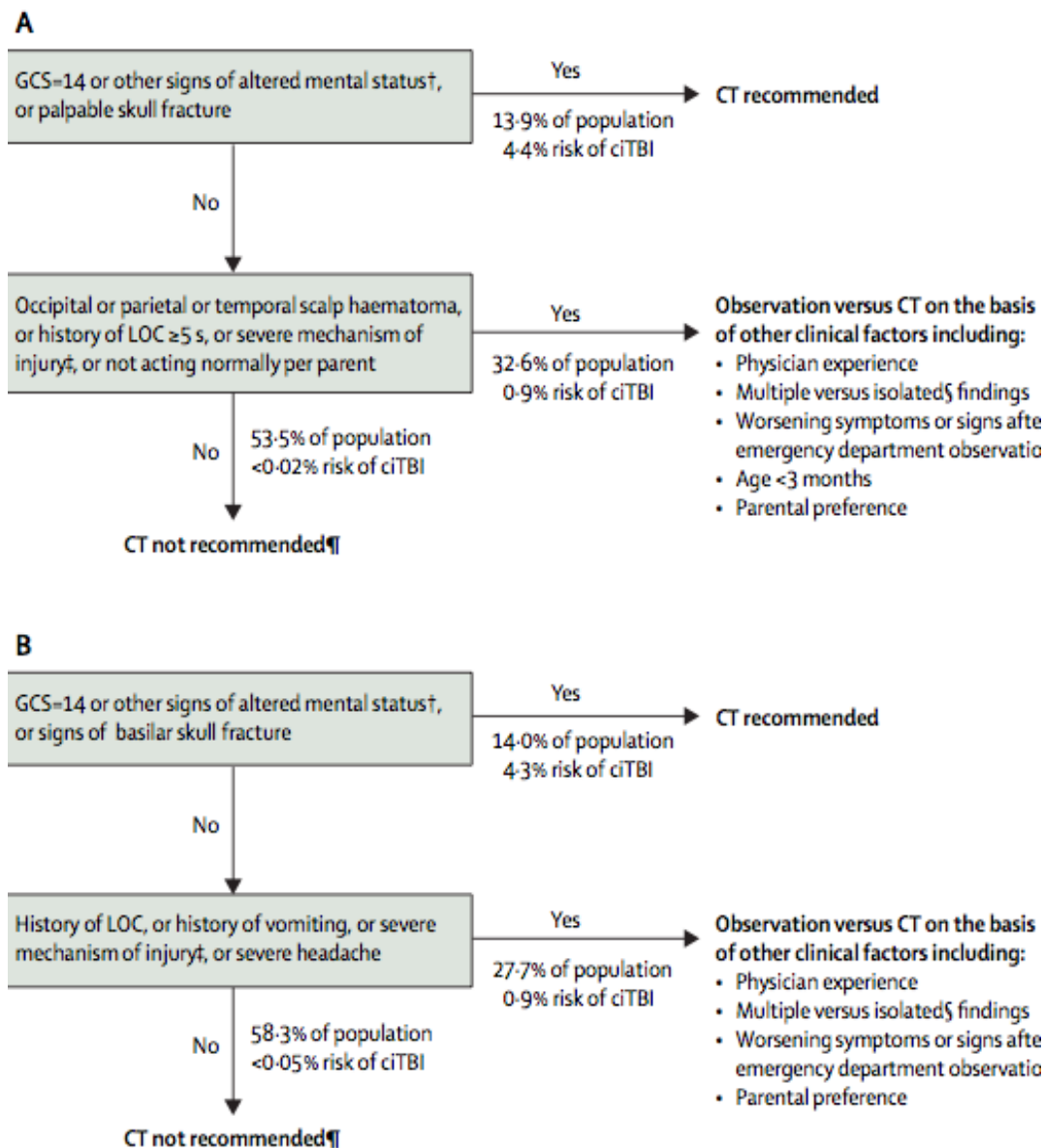
Pediatric Glasgow Coma Scale

For Patients > 2 Years Old

Eye Opening	(4) Spontaneous (3) To Voice (2) To Pain (1) None
Verbal Response	(5) Oriented (4) Confused (3) Inappropriate Words (2) Incomprehensible (1) None
Motor Response	(6) Obeys Commands (5) Localizes Pain (4) Withdraws to Pain (3) Flexion (Pain) (2) Extension (Pain) (1) None

For Patients ≤ 2 Years Old

Eye Opening	(4) Spontaneous (3) To Voice (2) To Pain (1) None
Verbal Response	(5) Coos, Babbles (4) Irritable Cry (3) Cries to Pain (2) Moans to Pain (1) None
Motor Response	(6) Normal Spontaneous (5) Withdraws to Touch (4) Withdraws to Pain (3) Abnormal Flexion (2) Abnormal Extension (1) None



PECARN

- Minimize CT
- Observe when possible

Isolated Skull Fractures in Children (<3mm)

Who warrants admission

- Abnormal exam
 - Nausea, vomiting
 - Persistent headache
 - Altered affect/ irritability
 - Visual disturbances
- Concern for non-accidental trauma
- Lives far away
- All require neurosurgical follow up

Pediatric Neurological Extremis

Intervention Basics:

- Protect Airway- positioning, manage nausea
- Support Breathing & Circulation
 - Avoid hyperventilation
- Judicious use of fluids
- Decrease stimulation (manage ICP)
- Pharmacologic management
- Positioning- minimally elevate HOB (manage ICP)
- Prepare for transfer

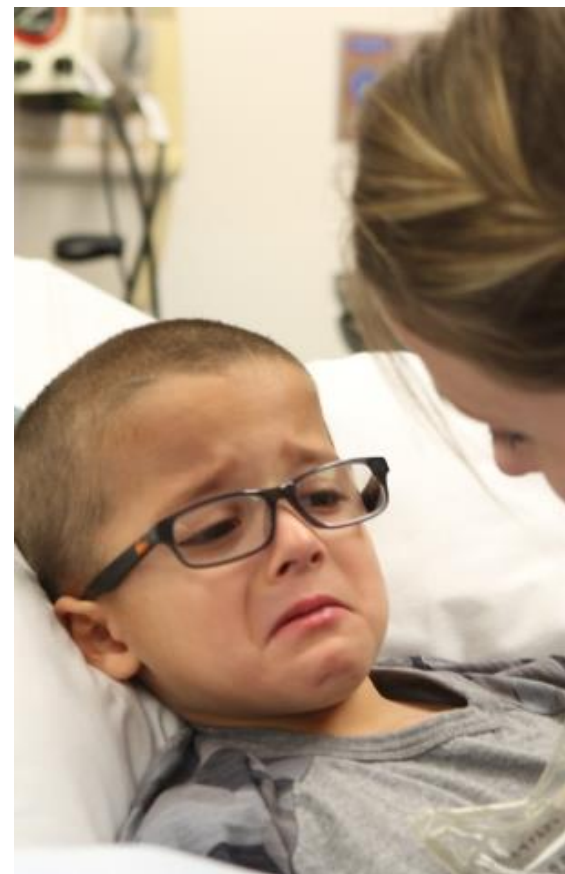
Children and Pain

- Many children have very little experience with intense pain, and do not have a frame of reference.
- Children will deny pain in an attempt to avoid an intervention.
- Pain is increased by anxiety.
- A child has a very rapid metabolism that requires pain medications dosed appropriately for weight, and given more frequently than with adults.



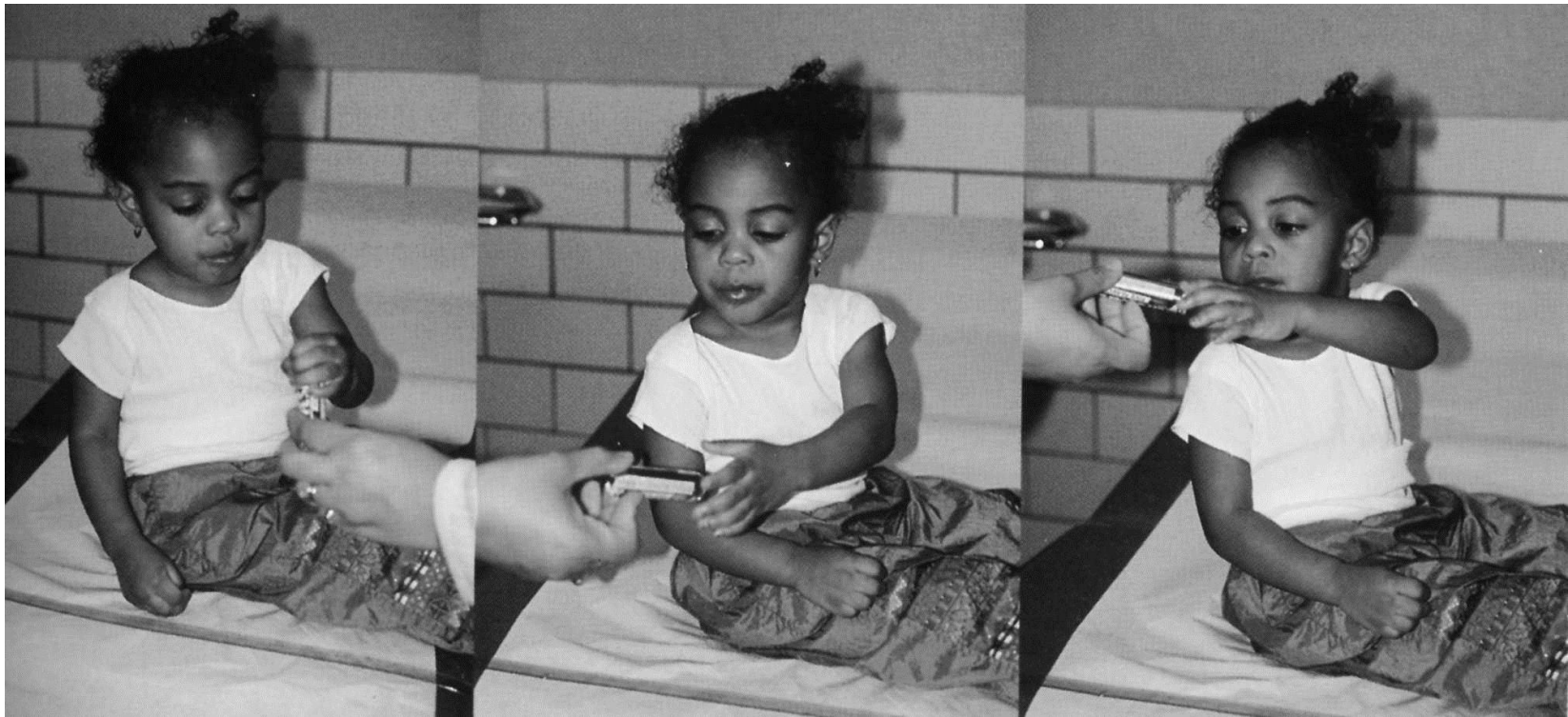
Children and Pain

- **Pain Control:** Intranasal Fentanyl
- Patients older than 6 months
- Not for CHI, ALOC, nasal trauma or blockage
- Fentanyl dose by kg is 1.5 microgram/kg (max dose 100 microgram)
- If more than 50 mcg, divide dose into volumes of <0.5 ml and wait 5 minutes b/n repeat dosing in the same nares



Muscular-Skeletal Injuries

Kaila was at the park today when her aunt noticed that she wasn't using her right arm. There is no history of falling or trauma but the aunt did swing her around by her arms while playing. She complains of her wrist and elbow hurting upon exam. Her VS are stable but her pain score is a 4 with FACES.



Child Maltreatment

Defined by the CDC:

“Any act or series of acts of commission or omission by a parent or caregiver that results in harm, potential harm, or threat of harm to a child.”

Your radar or level of concern should be activated when the account of the mechanism of injury does not fit the physical presentation.

NAT: Red Flags

- **History:** Changing or is inconsistent with identified injuries
 - **Delay in seeking care**
 - **Parent/caregiver affect:** hostile or indifferent
 - **Abusive Head Trauma:** cerebral edema, intracranial bleeds, retinal hemorrhage
 - **Fractures-** Isolated long bone fractures, ribs/sternal fx, complex skull fx
 - Humerus fx <3 yo 95% NAT, & femur <1 yo 60-70% NAT
 - **Bruising-** especially in non-ambulatory, near ears, or patterned (sentinel injury)
- *Listen to your inner voice- suspicion is sometimes a good thing!

A picture is worth a thousand words!



Beware of bruising on or behind the ear!

Another Case:



HPI:

- 7-year-old child, rear passenger unknown restraints, in high speed MVC (auto vs. tree at 60 MPH).
- Vehicle damage significant: One passenger DOA on scene, extrication time >20 minutes
- Patient with “prolonged” loss of consciousness and now lethargic.

What are the initial priorities of care?
Interventions?

Case: Putting it all Together

Patient at scene:

- **AIRWAY:** Patent, some secretions in mouth
- **BREATHING:** Respirations shallow
- **CIRCULATION:** Cool, tachycardic, weak pulse, noted abdominal distention
- **DISABILITY:** Lethargic, GCS=13, Waxing/Waning
- **EXPOSURE:** Multiple L arm abrasions

Vital Signs:

RR= 28

HR= 125

Temp=Cool to touch

Estimated wt. 30kg

Is this Extremis?

Interventions at Scene

IO placed-100 ml Normal Saline total Estimated wt. 30kg

Decision: Transport and get airway en-route

Failed Rapid Sequence Intubation (RSI)- Bradycardia & copious secretions

Bag-mask providing assistive ventilation on transit

Profuse emesis, immediate suction

Arrival at hospital

Vitals: HR- 180s, RR- 29, BP 85/65, O2 Sat-90%

Airway- ETT placed

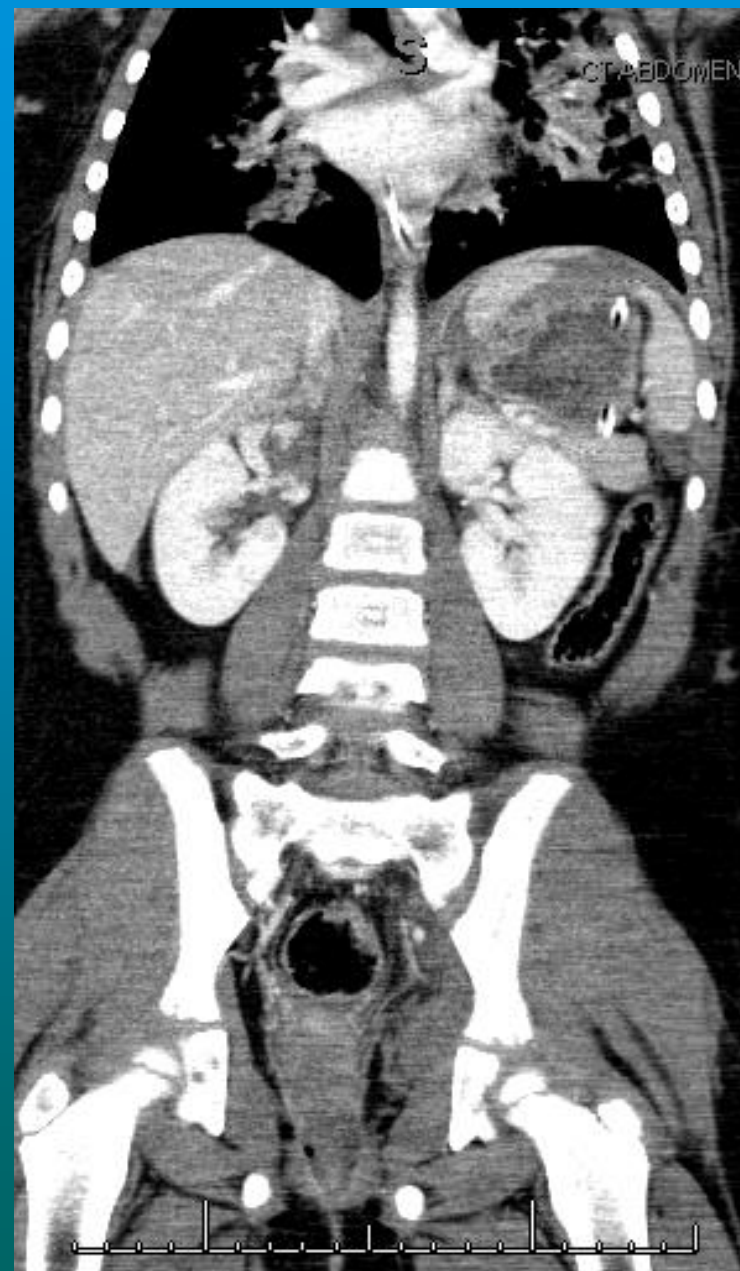
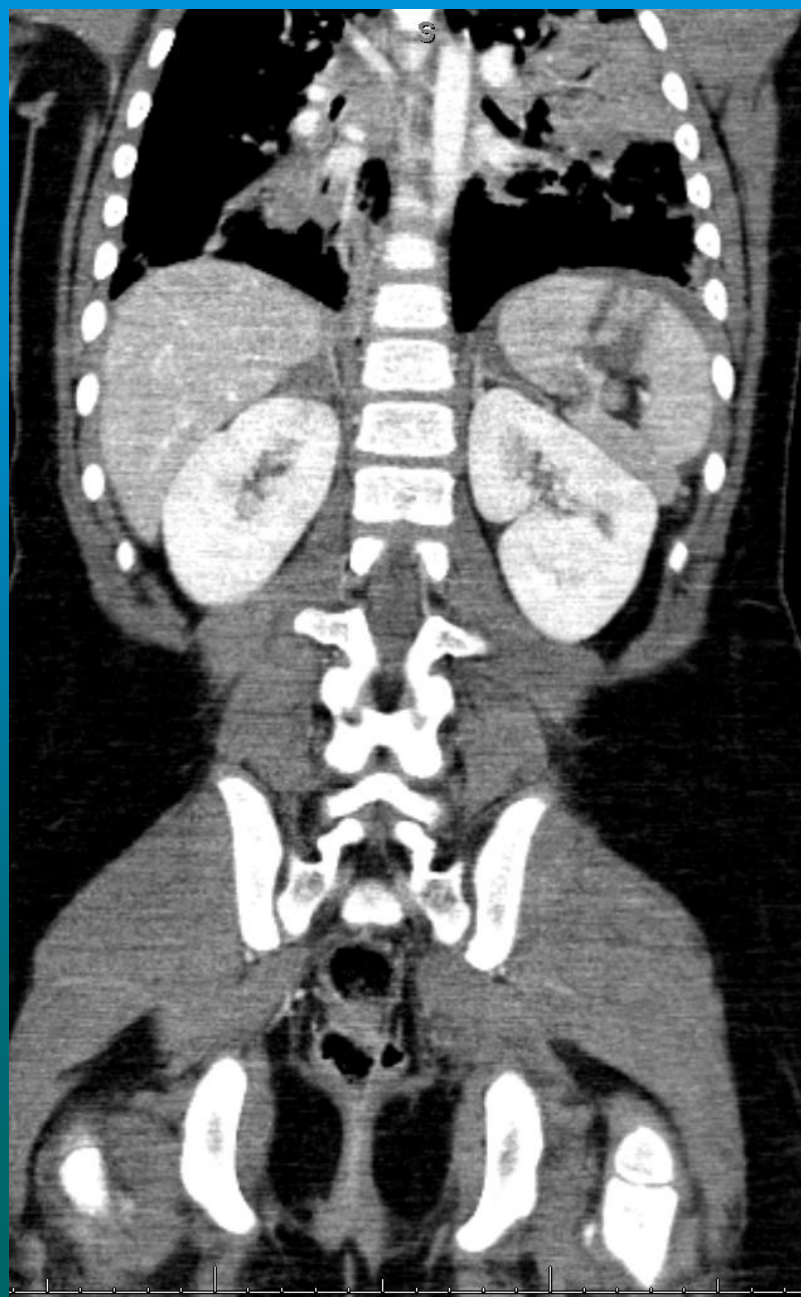
Breathing- Spontaneous

Circulation- Pale, cold, weak pulses

Disability- GCS= 7

*Noted abdominal distention

What are the Priorities?



Hospital Interventions:



- Sedated and definitive airway-Intubation
- Labs & crystalloid IV bolus
- Imaging- CT head, abdomen/pelvis

RX: Non-operative management in PICU

- Multiple solid organ injuries
- Acute Respiratory Distress
- Discharge home on hospital day 10

Was this Extremis to start with?

Should “non-operative management” be transferred
to higher level care?

Hospital Course

Non-surgical management

- Periodic episodes of hypotension 1st 24hours: BP 59/36
- Damage control resuscitation
 - Plasmalyte
 - Received blood components
(PRBC 3units, Plt. 2units, FFP 2units)
 - Dopamine
 - Maintain perfusion for TBI
 - ABX for possible sepsis from aspiration

INSANE
is such a
mean word.
I prefer
mentally creative.

Close Observation: What is Stable?

- Serial exams*
- Continuous VS and I&O monitoring
- Judicious use of crystalloids (20ml/kg)
- Response to initial bolus guides treatment
- Avoid hemodilution
- Monitoring labs

Communication is Key:

- define what will be target BP?
- when does the plan change?
- Diagnostics- CT, FAST, DPL/DPA
- Massive Transfusion Protocol (MTP)
- Tranexamic acid (TXA)- antifibrinolytic- use early

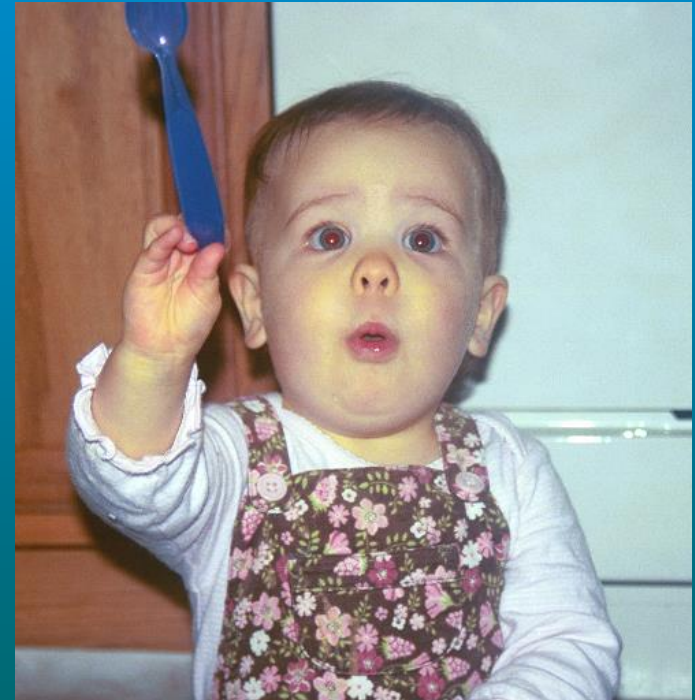


Summary

Concluding comments:

Get used to it,

Kids get hurt often!



Questions?